**Study Guide Science 5th grade -Weather and Climate**

**Weather-** the day to day changes of :

temperature, precipitation, wind and air pressure. Weather in a certain time and a certain place. Weather is always changing.

**Climate-** long term patterns over a period of time of an area. The average over many years. Climate changes very slowly.

**3 Major Climate Zones**

1. Tropical –warm and wet most of the year (equator)

2. Temperate (go through cycles of cold and snowy or hot and dry) in between areas

Temperate zones usually have four seasons (winter, spring, summer, fall)

3. Polar (cold and dry most of the year (North/South Poles)

**Temperature** – the measurement of the condition of the air. How warm or cool is the air?

**Wind Direction** – Which way is the wind blowing? Named for the direction from which it is blowing. IF the wind is blowing from the SW (Southwest) then the winds are considered SW winds.

**Types of Precipitation** – water that falls from clouds in either liquid or solid form.

1. Rain

2. Sleet

3. Hail

4. Snow

5. Freezing Rain (the atmosphere is warm but the temperature on the ground is freezing-so the rain freezes on contact)

**Air Pressure – the weight of the air.**  Warm air rising and cold air sinking combined with the spinning of Earth causes the air to spin forming high and low pressure regions.

**HIGH PRESSURE**:

**Cold air** is heavy and wants **to sink**, therefore making the air feel heavy and creating

**HIGH PRESSURE. (cold air is more dense so it drops) A high pressure system usually signals fair weather with winds circulating around the system in a clockwise direction.**

***The Weather is Cold and Dry when it is HIGH***

**LOW PRESSURE:**

**Warm air** is light and **wants to rise**, therefore making the air feel light and creating

**LOW PRESSURE. Warm air can hold more water than cold air. (warm air is less dense so it floats or rises-has more room) A low pressure system will signal rainy and stormy weather conditions with winds in a counterclockwise direction.**

***Warm and Wet Weather is What Low Pressure Gets***

**HIGH PRESSURE ALWAYS FLOWS INTO LOW PRESSURE. Cold air always wants to warm up. H L**

**Differences in Air Pressure/Temperature Cause Wind**

Air moves from places with high pressure to places with low air pressure.

This creates wind (the uneven heating of air-some air is warmer than other air)

The greater the difference in air pressure between the two places- and the shorter the distance between them- the stronger the wind.

**Storms**

Severe weather conditions called *storms* occur when air pressure differences cause rapid air movement.

Conditions that bring one kind of storm can also cause other kinds of storms in the same area.

* *Thunderstorm* is storm with thunder, lightning, heavy rains and strong winds; form within large cumulonimbus clouds; usually form along a cold front but can form within an air mass.
* *Tornado* is a rapidly whirling, funnel-shaped cloud that extends down from a storm cloud; the very low pressure and strong winds can cause great damage to people and property; are likely to form within the frontal regions where strong thunderstorms are also present.
* *Hurricane* is a low pressure tropical storm that forms over warm ocean water; winds form a spinning circular pattern around the center, or eye, of the storm; the lower the air pressure at the center, the faster the winds blow toward the center of the storm. Winds must be 74 mph to be classified as a hurricane.

**Cloud Chart**

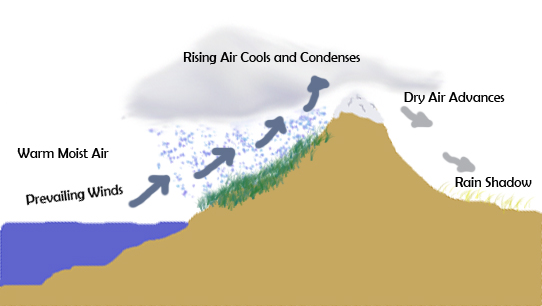
**Cloud Type Weather and Location**

|  |  |
| --- | --- |
| Cirrus (Curl)  689381_cirrus_clouds | High clouds, clear skies, no precipitation, formed from ice crystals, called thin, wispy or stringy |
| Cumulus (Heap)  MCj03111160000[1] | Middle clouds, fair weather, look like fluffy cotton balls |
| Stratus clouds2 | Low clouds, looks like a flat blanket, arranged in layers, cloudy skies, usually gray in color, most likely bring drizzle or rain |
| Cumulonimbus cumulonimbus-cloud-akbhhf-sw | Storm clouds that form in all layers of the atmosphere, strong winds, heavy precipitation. Dark in color.Thunderstorms.  Nimbo or Nimbus- (means rain producing) |

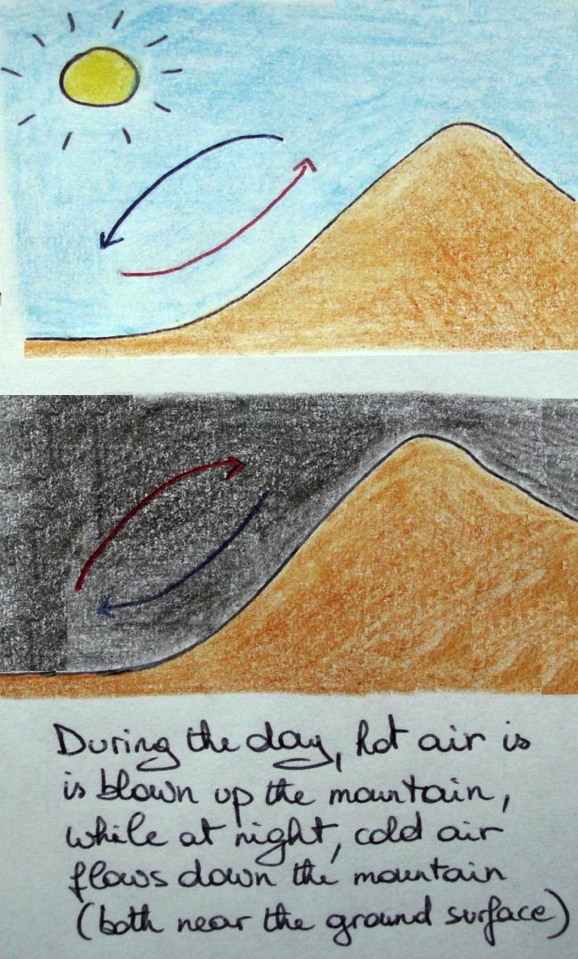
**Fog-** Clouds that form when condensation occurs at or near the ground

The prefix alto may be used to indicate medium-level clouds formed at about 2-6 kilometers up into the atmosphere, for example, altocumulus or altostratus.

**Rain Shadow –** lack of precipitation on the side of a mountain away from the wind, and can create deserts



**Mountain and Valley Breezes**



**Valley Breeze**- During the day, the sun heats up valley air rapidly. This causes it to rise, causing a warm, up slope wind.

**Mountain Breeze**-At night, the process is reversed. Mountain air cools rapidly at night and "falls" down slope, causing a wind going in the other direction.

**Lake-Effect Snow:** created as wind moves over a body of water, picking up moisture and falling as snow

**Windward:** the side of something facing the prevailing or MAIN wind

**Leeward:** The side of something facing away from the wind

**Land and Sea Breezes (High Pressure goes to Low Pressure)**

Sea Breeze

**Low Pressure High Pressure**

**Air is warm and light Air is cool and heavy**

**because the warm land is because the cool water is**

**heating up the air above it. cooling the air above it.**



When you are on the beach, **during the day** the sun heats **the land faster than the water** and makes the air above it hot this air rises and pulls in air from the sea to replace it, this is a **sea breeze.**

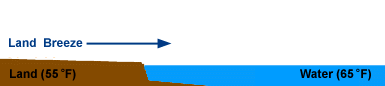
Land Breeze

**High Pressure Low Pressure**

**Air is cool and heavy Air is warm and light**

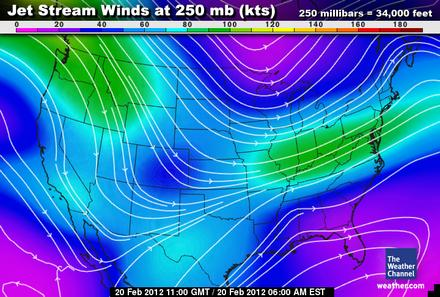
**because the cool land is because the warmer water is**

**cooling the air above it. heating up the air above it.**



**At night the land cools down** and when it is colder than the sea (**which remains almost the same temperature day and night**) then hot air rises from the sea surface and it pulls in air form the land, this is a **land breeze.**

**Jet Stream**



***Jet stream****-* A fast-moving ribbon of air that moves from west to east in the Northern Hemisphere around Earth. It dips and bends and constantly changes positions. **Jet streams are caused by 1) Earth’s rotation on its axis 2) Uneven heating of Earth**

As these changes occur, air masses and weather systems in its path are moved along by the fast moving air.

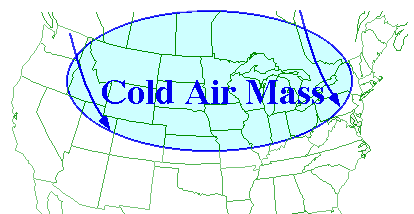
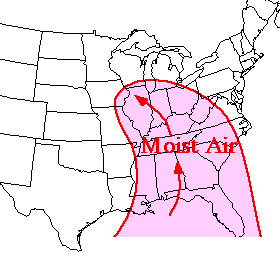
The polar jet stream can bring down cold polar conditions from the north.

The subtropical jet stream can bring warm tropical conditions from the south (in the northern hemisphere).

**Air Mass**

An air mass is a large body of air that has similar temperature and humidity throughout.

**Air Masses can be warm/wet, warm/dry, cold/dry, cold/wet etc. depending on where it originated (or came from).**

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**Polar Air Mass from Canada Maritime (Wet Mass from the Gulf of Mexico)**

**Fronts**

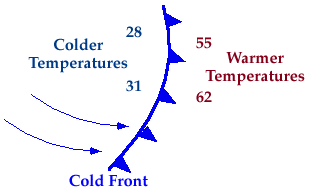
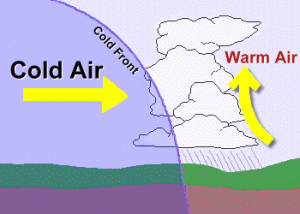
The line between two chunks (masses) of cold and warm air.

Fronts are boundary lines where to air masses meet. Storms often occur at fronts.

**Cold Front- Cold Air Replaces Warm Air**

**(shown by a blue line with triangles pointing to where the air is moving)**

**The warm air, which holds a lot of water vapor, gets pushed upward quickly.**

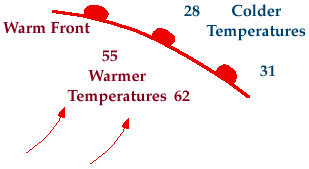
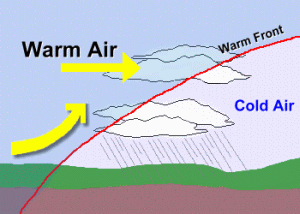
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**When a cold front passes through, temperatures can drop more than 15 degrees within the first hour. Also, usually causes heavy rains, sometimes with hail, thunder and lightning. This type of storm is often violent, but it ends quickly. After the front moves through, one can expect fair, cooler weather.**

**Warm Front- Warm Air replaces Cold Air**

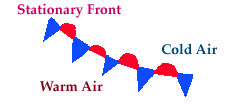
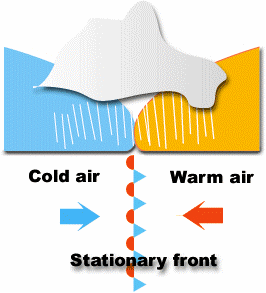
**(Shown by solid red line with semicircles pointing towards the colder air and in the direction of movement.)**

**The warm, humid air eventually rises high enough for water droplets and clouds to form, and rain to fall.**

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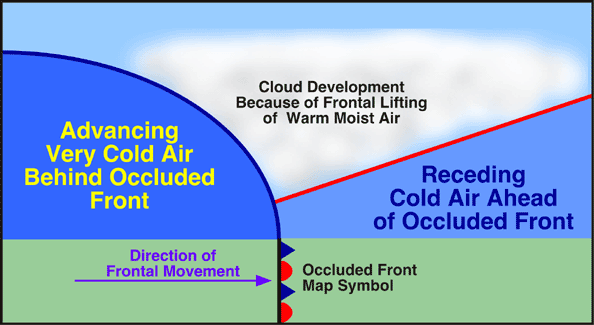
**When a warm front passes through, the air becomes noticeably warmer and more humid than it was before. Precipitation will be steady rain and will last longer than a cold front. When the warm front has passed through, it leaves warmer, more humid weather.**

**STATIONARY FRONT**: When two air masses meet, but neither of them wants to move. This lack of movement may happen because there is not enough wind to keep the air masses moving. During the front, one can expect many days of continuous rain. After the front, one can expect continued rain.



**OCCLUDED FRONT:**

As two cold air masses move toward each other, warmer air between them is pushed upward. An occluded front forms when a warm air mass is caught between two cold air masses. During the front, one can expect light rain or other precipitation. After the front moves in, there will be fair and cooler weather.

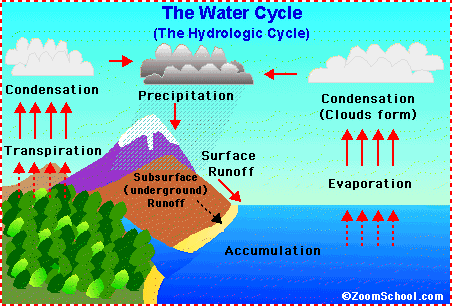


**Weather Instruments (Tools Meteorologists use to measure weather)**

|  |  |
| --- | --- |
| **Name of Tool** | **What it Measures** |
| **H**ygrometer | the **H**umidity or moisture in the air (how much water vapor) |
| **T**hermometer | **Measures T**emperature |
| Anemometer | Measures Wind Speed (how many miles per hour) |
| **R**ain Gauge | Measures Precipitation (Amount of **R**ainfall**)** |
| Weather Vane (Wind Vane) | Measures Wind Direction (North, East, South, West) |
| Barometer | **Measures** air pressure **(high or low)**  Based on inches or bpms |
| Doppler Radar | Direction and speed of rain drops as radar energy bounces off them |
| Weather Balloon | A balloon sent into the atmosphere to take measurements of air pressure, temperature etc. in the layers of the atmosphere |

Earth’s atmospheric layers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Atmospheric*  *Layers* | Earth’s atmosphere is divided into several different *atmospheric layers* extending from  Earth’s surface outward | the *troposphere*, where all weather occurs  the *stratosphere*, where the ozone layer is contained  the *mesosphere*  the *thermosphere*  the *exosphere* | | Earth’s  Surface  Space |
| *Atmospheric*  *Gases* | Nitrogen and Oxygen | the two most common gases; found throughout all the layers | | |
| Ozone | a form of oxygen found in the stratosphere | | |
| Water vapor and  Carbon dioxide | important gases for weather conditions; found in the  troposphere | | |
| Trace gases, argon | play an insignificant role | | |
| *Atmospheric*  *Temperatures* | Differences in temperature  separate the layers | As altitude increases, temperature decreases in the  *troposphere*  The *stratosphere* is cold except in its upper region where ozone is located  The *mesosphere* is the coldest layer  Even though the air is thin in the *thermosphere*, it is very hot  The cold regions of outer space extend from the *exosphere* | | |
| *Atmospheric*  *Pressure* | The *air pressure*, the force exerted by the gases pushing on an object, is greatest near the surface of Earth, in the *troposphere*. | Air pressure decreases  through the layers farther out from the surface as Earth’s pull of gravity decreases. | Troposphere pressure  decreases  Exosphere | |



Water Cycle

Water is always moving between the atmosphere (troposphere) and surface of Earth. Each components of the *water cycle* process has certain conditions under which each form of precipitation develops:

*Precipitation*

After condensation occurs (forming clouds), water droplets fall in various forms of *precipitation* – rain, snow, freezing rain, sleet, or hail, depending upon weather conditions.

Temperature variations within clouds and/or within the region between the cloud and Earth allows for the various forms of precipitation.

*Evaporation/Transpiration*

Water enters the atmosphere as water vapor (gas) through evaporation and transpiration, plants releasing water vapor. (Liquid to a gas)

*Condensation*

*Condensation* happens in the atmosphere as water vapor (gas) changes to water droplets (liquid).

Clouds form as a result of condensation.

*Dew* forms when water vapor condenses directly onto a surface;

*Frost* forms when water vapor changes from gas directly to ice crystals on a surface when the temperature at which condensing would take place is at the freezing point or below.

*Run-off*

If precipitation falls on land surfaces, it always attempts to move back toward sea level as *surface-water flow* or *(RUNOFF)*.

The surface that receives the precipitation determines its flow back towards sea level.

Examples are:

Water will remain on the surface when the surface is not porous or the precipitation is falling too fast for the water to sink into the ground.

Water will sink into the ground when the surface is porous and there is lots of space in the soil to hold the water.

**WEATHER FORECASTING**

Weather conditions and patterns can be predicted based on weather data collected from various sources.

*Direct Observations and Measurements*

Basic weather conditions can be observed and/or measured by *meteorologists* at national weather data collection sites.

In order to make weather predictions, the data should be collected on a regular basis over a period of time.

This allows for the development of patterns in weather conditions from the analysis of the data.

For example, a hurricane’s path can be predicted using data on its position over time (plotted on a hurricane tracking map), thereby allowing meteorologists to make predictions concerning the possible warnings to land areas in the hurricane’s path.

*Weather maps*

Weather maps can help predict weather patterns by indicating high or low pressure systems (*isobars*), movement of air masses and fronts, or temperature ranges (*isotherms*).

*Station models* from specific locations provide information that can also be used to predict weather patterns.

Information found on a station model can include cloud cover, temperature (85F), wind direction and speed, precipitation (snow, rain), or barometric pressure (1002 mb).

*Satellites*

Satellite images are used for seeing cloud patterns and movements.

For example, hurricane clouds and movement can be observed using satellite images.

*Radar*

Radar images can be used to detect cloud cover, rainfall or storm location, intensity, and movement, as well as the potential for severe weather (for example, hurricanes or tornadoes).

**SOLAR ENERGY**

The driving energy source for heating of Earth and circulation in Earth’s atmosphere comes from the Sun and is known as *solar energy*.

Some of the Sun’s energy coming through Earth’s atmosphere is reflected or absorbed by gases and/or clouds in the atmosphere.

The land heats up and releases its heat fairly quickly, but water needs to absorb lots of solar energy to warm up. This property of water allows it to warm more slowly but also to release the heat energy more slowly. It is the water on Earth that helps to regulate the temperature range of Earth’s atmosphere. Remember water takes longer to heat up and cool down than land. Land heats up and cools down **faster** than water.

Solar energy that is absorbed by Earth’s land and water surfaces is changed to heat that moves/radiates back into the atmosphere (troposphere) where the heat cannot transmitted through the atmosphere so it is trapped, a process known as the *greenhouse effect*.

**CONVECTION CURRENTS**

Because warm air near Earth’s surface rises and then cools as it goes up, a *convection current* is set up in the atmosphere. There are three atmospheric convection areas in the northern hemisphere and three in the southern hemisphere.

the *tropical region* begins at the equator and extends to the about 30 degrees north latitude;

the *temperate region* extends from there to about 60 degrees north latitude, and

the *polar region* extends from there to the north pole, 90 degrees north latitude.

Convection happens on a global scale in the atmosphere and causes global winds. These winds then move weather systems and surface ocean currents in particular directions.

Due to the spinning of Earth, the weather systems in these regions move in certain directions because the *global wind belts* are set up.

On a smaller scale, convection currents near bodies of water can cause local winds known as *land and sea breezes*.

The *surface currents* of Earth’s oceans that circulate warm and cold ocean waters in convection patterns also influence the weather and climates of the landmasses nearby.

The warm Gulf Stream current water influences the eastern Atlantic shoreline of the United States, while the cold California current influences its western Pacific shoreline.

Because of the unequal heating of Earth, *climate zones* (tropical, temperate, and polar) occur.

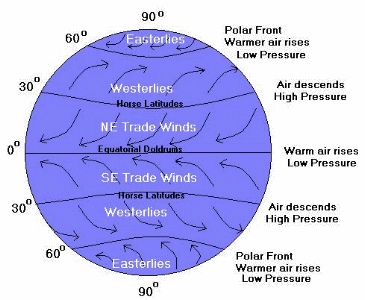
Since temperature is a major factor in climate zones, climate is related to:

* the convection regions at various latitudes,
* temperature differences between the equator and the poles, and also
* warm and cold surface ocean currents.

**GLOBAL WINDS**

*Global winds* are found in each convection region.

Because convection cells are in place in the atmosphere and Earth is spinning on its axis, these global winds appear to curve. This is known as the *Coriolis effect*.



In the global wind belt regions, the prevailing direction of the winds and how air movement in these large regions affects weather conditions.

The *trade winds* blow from east to west in the tropical region moving warm tropical air in that climate zone.

The *prevailing* *westerly winds* blow from west to east in the temperate region. These control our weather.

The *polar easterlies winds* blow east to west in the polar region moving cold polar air in that climate zone from the poles toward the west.

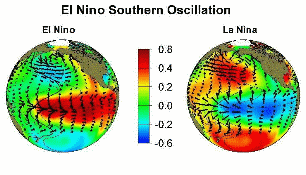
The temperate zone temperatures are affected most by the changing seasons, but since the westerly wind belt is in that region, the weather systems during any season move from west to east. Since the United States is in the westerly wind belt, **the weather systems move across the country from west to east.**

Tropical weather systems, for example hurricanes, are moved in the prevailing direction of the trade winds. If they enter the westerly wind belt, they are often turned, and move in the direction of that prevailing system.

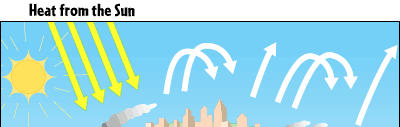
**EL NINO**

**What is El Niño?**  
El Niño is a climate pattern where the water in the Pacific Ocean near the equator gets hotter than usual and affects the atmosphere and weather around the world. El Niño climate conditions occur every few years, and they are not predictable. El Niño is Spanish for The Little Boy. It refers to the Christ child and was named by Mexican fisherman, who noticed the climate pattern often formed around Christmastime.

|  |  |
| --- | --- |
| Normal Year | El Nino Year |
| OneIn a normal year, the warmest water is in the far western Pacific. This forms thunderstorms.  (Graphic Credit:  USA TODAY) | TwoIn an El Niño year, the warmest water moves eastward across the Pacific. Thunderstorms disrupt the jet stream changing the weather pattern. |

**What type of a climate pattern do we see with an El Niño?**  
The climate pattern can change the weather of the United States, particularly in California and the southern states. Usually, El Niño brings more rain and higher temperatures. Also, warm ocean currents come farther north and all kinds of tropical fish can be caught in the waters far north along the United States West Coast. El Niño may also bring warmer than normal winter temperatures to the eastern part of the United States.   
**LA NINA:**  
**What is La Niña?**  
La Niña is sort of the opposite of El Niño. During a La Niña, the water in the same area along the equator gets colder than usual. This, too, affects weather around the globe and in the U.S. According to scientists, La Niña cycles generally create a more active hurricane season in the Atlantic.  
  
**What type of climate pattern do we see with La Niña?**  
In the United States, La Niña is expected to bring above normal temperatures throughout most of the Southwest and southern Florida in the late summer and fall. These warmer conditions will extend across the Southeast during the winter months. Cooler than normal winter temperatures are expected in the Pacific Northwest. Cooler than normal temperatures are also expected across the Great Lakes and Northeast later in the winter into spring. In addition to temperature effects, La Niña is also expected to affect rainfall. Drier than normal conditions will persist in west Texas, New Mexico and Arizona into October. The late fall and early winter forecasts indicate continued dry conditions throughout much of the southern U.S. and into portions of the Midwest. Above normal precipitation is predicted for much of the Pacific Northwest throughout the fall and into the winter months, and in the Ohio and Tennessee River Valley in the winter.

**WHAT IS GLOBAL WARMING?**

**What is Global Warming?**  
Global warming refers to an average increase in the Earth's temperature, which in turn causes changes in climate. A warmer Earth may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities. (Graphic Credit: World Almanac Education Group)  
  
  
  
  
**Is the Earth getting warmer?**  
Yes! The Earth has warmed by about 1ºF over the past 100 years. But why? Well, scientists are not exactly sure. The Earth could be getting warmer on its own, but many of the world's leading climate scientists think that things people do are helping to make the Earth warmer.

**GREENHOUSE EFFECT**:

**What is the Greenhouse Effect?**  
The greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere like water vapor, carbon dioxide, nitrous oxide, and methane trap energy from the sun. Without these gases, heat would escape back into space and Earths average temperature would be about 60ºF colder and would not be warm enough for humans to live. But if the greenhouse effect becomes stronger, it could make the Earth warmer than usual. (Graphic Credit: EPA)  
